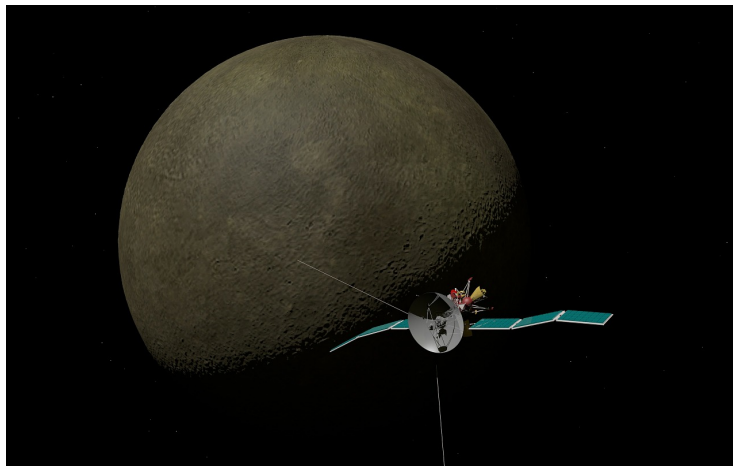


## 7.6: Missions to Mercury and Venus.

### 7.6.1 Missions to Mercury

Getting to Mercury is not easy. That close to the Sun, a probe must contend with the high temperatures and the gravity of the Sun, either of which could jeopardize a mission to the smallest of the planets.

To date, only two probes have visited Mercury. Launched on November 3, 1973, Mariner 10 made its first flyby of Mercury on March 24, 1974. Later, it made two more passes on September 21, 1974 and March 16, 1974. Because the same side of Mercury was illuminated by the Sun on each flyby, however, Mariner 10 only mapped about 45% of the planet's surface. Mariner 10 also detected a magnetic field around Mercury.



Artist's conception of the MESSENGER probe.

<https://www.needpix.com/photo/269915/mercury-planet-solar-system-space-travel-landing-technology-target-vision-brown;>

The MErcury Surface, Space ENvironment, GEOchemistry, and Ranging (MESSENGER) was launched on August 4, 2004 and made several passes around Earth, Venus, and Mercury from 2005-2008. MESSENGER entered orbit of Mercury in 2011. It made the first detailed observations of Mercury and exceeded its initial plans. MESSENGER managed to map the entire surface of Mercury. Then in 2015, after two mission extensions, it ran out of propellant was allowed to crash into the planet.

As of this writing, a third probe is en route to Mercury. BepiColombo, Joint ESA-JAXA mission to Mercury was launched on October 20, 2018. After making several passes around Venus and Earth, it is due to arrive in 2025. The mission comprises two spacecraft: The Mercury Planetary Orbiter (MPO) and the Mercury Magnetospheric Orbiter (MMO). BepiColombo will orbit Mercury as it attempts to determine if its core is solid or liquid, whether planet has any active plate tectonics, and learn more about Mercury's composition.





### 7.6.2 Missions to Venus

Venus has posed other challenges to observers on Earth. Because of its extensive cloud cover, the surface of Venus cannot be mapped using visible light. In the 1960s, NASA's Goldstone and the Arecibo telescope began using radar to map the planet. This enabled us to determine the planet's rotational period, axis of rotation, and planetary radius for the first time. From the sixties until the mid-eighties, the Soviet Union sent numerous probes to study Venus, most of which failed. While the Soviets were determined to land a probe on Venus, NASA launched relatively few probes to Venus, all of which were either flyby or orbiter missions.

<b>Spacecraft</b>	<b>Launch Date</b>	<b>Operator</b>	<b>Mission Type</b>	<b>Result</b>
<i>Tyazhely Sputnik</i>	2/4/61	USSR	Impactor	Launch failure
<i>Venera 1</i>	2/12/61	USSR	Impactor	Spacecraft failure
<i>Mariner 1</i>	7/22/62	NASA	Flyby	Launch failure
<i>2MV-1 No.1</i>	8/25/62	USSR	Lander	Launch failure
<i>Mariner 2</i>	8/27/62	NASA	Flyby	Successful
<i>2MV-1 No.2</i>	9/1/62	USSR	Lander	Launch failure
<i>2MV-2 No. 1</i>	9/12/62	USSR	Flyby	Launch failure
<i>2MV-2 No. 1</i>	2/19/64	USSR	Flyby	Launch failure
<i>Kosmos 27</i>	3/27/64	USSR	Flyby	Launch failure
<i>Zond-1</i>	4/2/64	USSR	Flyby/lander	Spacecraft failure
<i>Venera 2</i>	11/12/65	USSR	Flyby	Spacecraft failure
<i>Venera 3</i>	11/16/65	USSR	Lander	Spacecraft failure
<i>Kosmo 96</i>	11/23/65	USSR	Flyby	Launch failure
<i>Venera 4</i>	6/12/67	USSR	Atmospheric	Successful (First manmade enter the atmosphere of Venus)
<i>Mariner 5</i>	6/14/67	MASA	Flyby	Successful
<i>Kosmos 167</i>	6/17/67	USSR	Lander	Launch failure

Venera 5	1/5/69	USSR	Atmospheric	Successful
Venera 6	1/10/69	USSR	Atmospheric	Successful
Venera 7	8/17/70	USSR	Lander	Partially successful (Landed on its side, making it the first soft landing on another planet. Only returned partial data)
Kosmos 359	8/22/70	USSR	Lander	Launch failure
Venera 8	3/27/72	USSR	Lander	Successful
Kosmos 482	3/31/72	USSR	Lander	Launch failure
Mariner 10	11/3/73	NASA	Flyby	Successful
Venera 9	6/8/75	USSR	Orbiter/lander	Successful
Venera 10	6/14/75	USSR	Orbiter/lander	Successful
Venera 11	9/9/78	USSR	Flyby/lander	Partially successful (some instruments failed)
Venera 12	9/14/78	USSR	Flyby/lander	Partially successful (Both cameras on lander failed)
Pioneer Venus 1	5/20/78	NASA	Orbiter	Successful
Pioneer Venus 2	8/8/78	NASA	Atmospheric	Successful
Venera 13	10/30/81	USSR	Flyby/lander	Successful
Venera 14	11/4/81	USSR	Flyby/lander	Successful
Venera 15	6/2/83	USSR	Orbiter	Successful
Venera 16	6/7/83	USSR	Orbiter	Successful
Vega 1	12/15/84	USSR	Flyby/atmospheric/lander	Successful
Vega 2	12/21/84	USSR	Flyby/atmosphere/lander	Successful (last Soviet mission to Venus)
Magellan	5/4/89	NASA	Orbiter	Successful (Used Radar to map the planet)
Galileo	10/18/89	NASA	Gravity assist	Successful (gravity assist en route to Jupiter)
Cassini	10/15/97	NASA/ESA	Gravity assist	Successful (gravity assist en route to Saturn)
MESSENGER	8/4/04	NASA	Gravity assist	Successful (gravity assist en route to Mercury)
Venus Express	11/9/05	ESA	Orbiter	Successful
Akatsuki	5/20/10	JAXA	Orbiter	Successful (still operation)
IKAROS	5/20/10	JAXA	Flyby	Successful (experimental solar sail deployed by Akatsuki)

<i>Shin'en</i>	5/20/10	JAXA	Flyby	Spacecraft failure (communication lost and past Venus)
<i>BepiColombo</i>	10/20/18	ESA/JAXA	Gravity assist	Successful (made two flybys for gravity assist en route to Mercury)

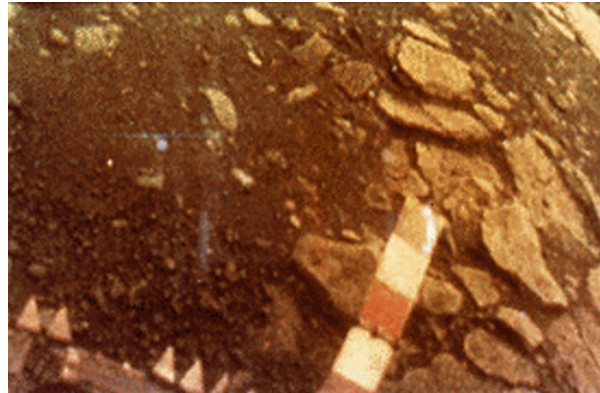


Image of the surface of Venus from one of the Soviet Venera landers.

<https://search.creativecommons.org/photos/41a0c0e4-af0d-48cd-8575-1db90b7c68dc;>



### Cloud cities on Venus?

Several agencies around the world have future missions planned or proposed for Venus. Some scientists have suggested that Venus might be the place to establish a cloud city, like the one portrayed in *Star War: The Empire Strikes Back*. Because carbon dioxide is heavier than breathable air, you could fill a balloon with a nitrogen/oxygen mix and it will float at that level. At about 30 miles about the surface, the pressure is close to that on Earth and the temperatures are more bearable than the hellish conditions on the surface. A 1-km diameter spherical balloon could lift 700,000 tons (about two Empire State Buildings) while a balloon 2-km in diameter could lift 6 million tons! Colonists could (theoretically) live inside these balloon cities and use robots to mine the surface.

NASA has a proposal called HAVOC (High Altitude Venus Orbital Concept). This would involve sending astronauts to Venus with a dirigible that they could fill with ordinary air. They could then pilot this airship 30 miles above the surface where the pressure is close to that of the Earth.



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